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Quantity Measurement Cost and Reliability of Cereal Commodity Trade: Evidence from Ethiopia

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Abstract: Measurement reliability is an undervalued aspect of local agricultural marketplace organizations. There are also gaps in identifying the extent of cereal commodity trade measurement costs. Therefore, the aim of this paper is to estimate the magnitude of cereals trade quantity measurement cost caused by instrument error and unreliability in the context of the local marketplace in Ethiopia. In this regard, a survey was conducted in six different districts' marketplaces (n = 602) of Oromia regional state. In addition to administered structured questionnaires, site mass measurement calibration was employed. The survey data were analysed using an independent samples t-test, one sample t-test and analysis of variance. According to the findings, the actual value measurement means of the quantity of most local units of the farmers were greater than small traders. The independent t-test result indicated that the average values of the quantity of the majority of units of measurement between farmers and small traders were varied significantly. Estimated average measurement cost of the farmers and small trader which occurred due to measuring instruments' error and unreliability were higher for a sack, bowl and glass units compared with other units of measurement. This study demonstrates that homogeneity in measurement, market regulatory policy and institutions that aid cereals trade have an indispensable role to reduce measurement costs thereby ensure equitable exchange.

Keywords: local agricultural marketplace; cereal commodity trade; quantity measurement costs; measurement reliability; Ethiopia

1. Introduction

Reliable quantity measurement system has a paramount contribution for economic transaction certainly for reducing the costly transfer of wealth. In Ethiopia, the district level agricultural marketplace is known for trading numerous products. Most people are currently relying on the local marketplace sales location for their agricultural output trade [1]. However, the majority of economic agents are exchanging the cereal commodity in local marketplace by employing multiple, non-uniform and incoherent units of measurement. The local units of quantity measurement are ranging from volumetric (glass, various can and cup, jug and bowl) to weight measures (sack) and mechanical weight balance. In addition, the diverse measuring instrument of the same kind, method of measuring and ways of using instruments are widely used to undertake cereals trade [2]. Moreover,

cereal quantity measurement behaviour of trading parties demonstrates the existence of unreliability. The unreliability in measurement behaviours created the cost of transaction, measurement, social capital and two-hand palm cereal gift in contexts of Ethiopia local marketplace [2]. In general, the heterogeneity of the measurement system creates considerable measurement costs, exchange inequity and market disintegration [3–8].

Nevertheless, the extent of measurement costs happening due to diverse units in local marketplaces are not yet investigated. The quantity measurement reliability of cereal transaction between marketplace exchange parties over periodic market days, repeated measurement and amongst districts are not known as well. Furthermore, there has been inadequate perception about who is gaining and who is losing in the process of measurement of cereal commodity trade. Generally, it is not simple to create a clear line of agreement about the impact of complex and conventional measurement system upon the local economy of a given nation.

Scholars suggest standardized measures; the extension of Ronald Coase's arguments of the nature of the firm to the nature of the market to minimize the transaction costs [9–14]. First, since the introduction of metric and imperial measures, the emphasis of many countries was on metrological standardization [15]. But the diffusion of metric and imperial units of measurement to developing countries was not successful for a long period of time [16]. Ethiopia government has been implementing metric units of measurement since 1963 [16]. Nevertheless, the diverse kind of local measures are still widely in use in the rural parts of the country. Furthermore, the positive effect of standardized measures upon local economy and measurement problems management are yet unidentified.

In addition, the extension of Coase's arguments of the nature of the firm to the nature of the market as an organization has an implication for rural trading parties to economize transaction cost. In this regard, the work of Coase is contributing that the economic transaction coordinated through the institution firm can better save marketing costs than the same transaction organized through the invisible hand of the market institution [13]. Indeed, a particular market institution like a firm institution that lessen transaction costs are essential for the marketplace trading system. However, over 80 years, the contribution of Coase's essay, costs of using the price mechanism, has still not acquired vital academic consideration to solve the real economic growth obstacles such as local marketplace measurement problems.

Therefore, as a solution to the aforementioned disputes, the study aimed at estimating the extent of cereals quantity measurement costs caused by error and unreliability of measuring units in local marketplace of Ethiopia. The study also investigate the quantity measurement reliability from consistency, conformity and uniformity perspectives. In general, the study has empirical and practical contribution to new institutional economics theory. First, few studies have attempted to estimate the level of transaction costs due to the difficulty of measuring these costs [17,18]. Add more, many studies conducted so far overlooked the measurement behaviour and related cost in their definition of transaction cost [19,20]. This study is, therefore, pinpointing that the measurement cost need to be considered as part of transaction cost estimation. Second, it assists as way out to manage measurement cost thereby stakeholders of local marketplace maximize cereal trade gains.

2. Literature and Conceptual Framework

Literally, sources of measurement problems are viewed from two controversial angles. The causes of the measurement problems at the transactional level are emanating from the measurement error [8]. The premise behind this view is that the measurement cost is occurred due to measuring instrument bias or random errors. Hence, managing of measurement issues has been claimed from the management of error or instrument bias predominantly by targeting a given specific measurement unit. On the other hand, measurement reliability or sameness argue that error approach is a narrower and simplistic method to address the entire sources of measurement problems [21,22]. Thus, the originator of the sameness approach, Velker, suggests reliability dimensions (consistency, conformity and uniformity) in his method for addressing the holistic problems of measurement and to fill the gap

of the error method. Indeed, measurement costs are happening both in the case of instrument bias and/or the unreliability of measurement system.

3. Methods and Materials

3.1. The Study Site

The aggregate cereal production of the Oromia region alone comprised about 44.5 percent of Ethiopia in 2015 [23]. East and West Shoa zones were chosen among six popular zones in cereal commodity production in the region [24] (Figure 1). Three study areas were taken from each zone. The selected areas are known in producing cereals. Based on the data obtained from the zonal administration, the total post-harvest cereals production of East and West Shoa Zone in 2015 was 7,965,315 and 15,652,419 quintals (1 quintal is equivalent to 100 kg), respectively [25]. Of which, 57.49 and 21.28 percent were produced in Adea, Gimbichu and Lume (East Shoa) and Dendi, Bako-Tibe and Adea Berga (West Shoa) districts, respectively.

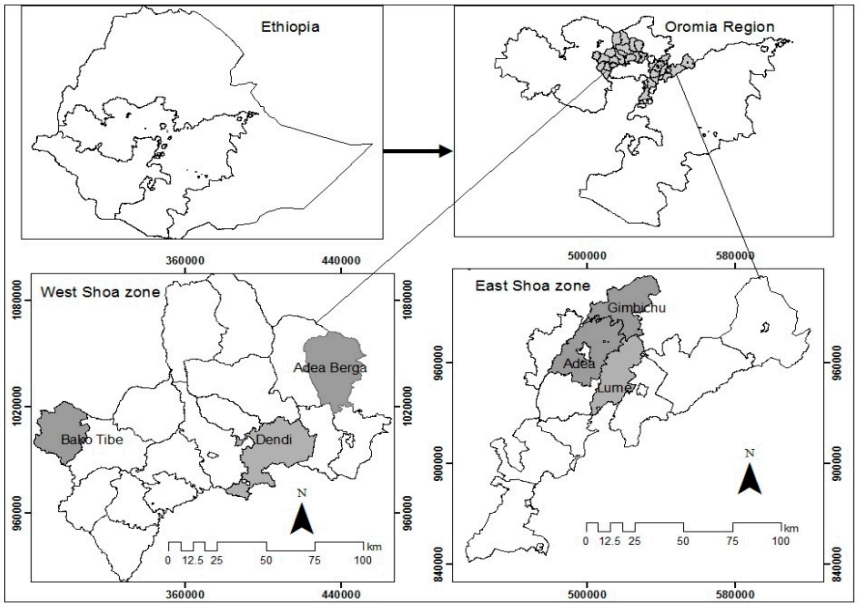

Figure 1. Map of the study area.

3.2. Sampling Methods

The study areas were selected using purposive and random sampling methods. The inclusion criteria were the relative volume of cereals production [23] and proximity to the capital city of the country. Furthermore, cereal commodity consumption expenditures of the household [26] and the cereal trade centre factor were considered. To this end, six district marketplaces—Bako-tibe, Dendi, Adea-Berga, Adea, Gimbichu and Lume—were selected for the purpose of the study. The sample of the farmer was determined by using a supposition of 5 percent level of precision; 95 percent level of confidence; 50 percent degree of variability; and the total size of the population [27]. Accordingly, the total sample size (n = 400) was distributed into six districts' marketplace depending on their respective number of the farmer households. As a result, the sample size for Dendi, Bako-tibe, Adea-Berga, Adea, Gimbichu and Lume marketplaces were 91, 67, 65, 67, 56 and 54, respectively. In addition, the small traders buying cereals from the same marketplace or another in order to re-sell them to various parties were included. The small trader population was, therefore, any small trading agent selling cereals in each chosen marketplace from 10 July 10 to 2 September 2018. The small trading agent who was buying from the nominated marketplace and selling to non-selected districts were not considered. Hence, 202

(n = 202) small traders from Dendi (43), Bako-Tibe (33), Adea-Berga (31), Adea (33), Gimbichu (31) and Lume (31) were addressed, respectively.

3.3. Data Type and Methods of Collection

In this study, both primary and secondary data were employed. The primary data was collected using the survey method through administered structured questionnaires from 10 July to 2 September, 2018. The survey was mainly focused on the socio-economic characteristics of farmers and small traders, type and variety of cereal traded, the total supply of cereal marketed and marketplace conversion convention between measuring instruments and kilogram unit. Besides, measuring instruments used for transaction, cereals amount of measuring units (kilogram), exchange price of cereals quantity of each unit were emphasized. To measure and record the actual value of the amount of quantity of each instrument, site calibration for the mass measurement in accordance with international system mass unit standard was performed in collaboration with National Metrology Institute of Ethiopia (Table A4). Moreover, the secondary data was obtained from journals, books, working papers and official reports. The district level agricultural marketplace observation was farther conducted to supplement the survey.

3.4. Methods of Data Analysis

The data were analysed by using Statistical Package for Social Sciences (SPSS version 23), (IBM corporation, New York, NY, USA), particularly through descriptive statistics such as percentage, independent and one samples t-test and analysis of variance. The OriginPro 9.1 (OriginLab Corporation, Guangzhou, China) data analysis and graphing software were also employed to illustrate market conversion convention between measuring instruments and kilogram unit and actual values distribution of the quantity of measuring units.

3.5. Measurement Cost Estimation

The study applied two methods to estimate cereals trade measurement costs magnitude of the farmers and small traders in each marketplace. At the district level, agricultural market organization structure of cereal commodity trade is hierarchical. There are two to three marketplaces (MP) in each district. Each marketplace has two to three measurement unit-based market divisions (MD) (Figure 2).

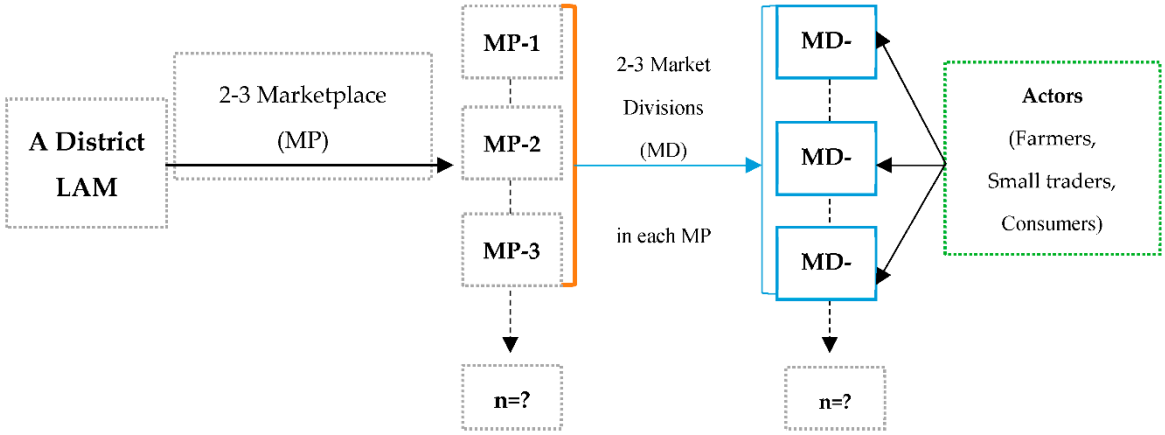

Figure 2. Local Agricultural Market (LAM) structure of cereal commodity trade. Source: Developed from the marketplace observation.

In this structure, each marketplace instrument bias and unreliability of cereal quantity measurement were evaluated for both farmers and small traders. The difference between the actual (real) and ideal (true) value of the amount of individual instrument was assessed to estimate error related measurement cost size. In this undertaking, the actual measurement value average of local

units was computed and served as the ideal value. Because most local units used for commodity trade did not have its own scientific standard. In this regard, two things were identified during preliminary study. First, the market convention between quantity of local units and kilogram were studied. Second, the actual value of quantity of each units (in kilogram) was measured using field calibration system. Thus, based on this pilot study, the market conversion convention between measuring instruments and kilogram unit was not used. Because, the market convention and actual measurement values of quantity of most local units were substantially different. Thereby, the difference between the actual value of the quantity of measuring units and their average was considered as instruments' error. However, the study applied the range conversion convention between the sack and kilogram as an ideal value; specifically to compute the commodity amount of a sack unit's actual value mean using a one samples *t*-test. For instance, most markets agreed that the teff quantity of a sack unit is equivalent to 74–80 kg. Such a range conversion convention is comparatively similar to the actual value compared to a fixed conversion volume between other local instruments and kilogram units. Besides, the market conversion convention of each instrument was considered as a baseline to estimate the measurement cost over trading parties' total cereals supply. According to the pilot study, there was no common convention of local units to a metric unit. This study, thus, used the conversion agreement of local units agreed by the majority of respondents. In general, the actual measurement average computation method was regarded as an ideal value of local units to estimate error related measurement cost using the Figure 3 framework.

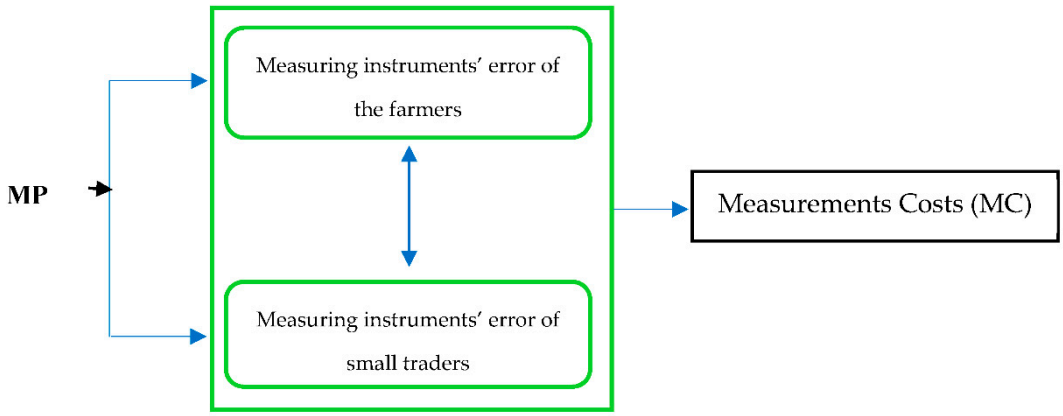

Figure 3. Local units' bias based measurement costs of farmers and small traders.

Measuring instruments' unreliability cost were measured from consistency, conformity and uniformity dimension. Measurement consistency deal whether the measurements remained consistent over time, whether measurement made in a given day is consistent with measurements made a day ago, a week ago, a month ago or a year ago [21]. For local marketplace context, markets are conducted once or twice or more in a week. Every week, the nature of one day market is very attractive (hot), in which farmers relatively supply more products and highly populated market day than that of slack market day. Hence, evaluating measurement unit consistency between a hot and slack market day of the same marketplace is essential.

On the other hand, the measurement is precise, if measurements over repeated observation closely resembled an acceptable or pre-specified value [21]. In the rural marketplace, unlike measurement protocols are existing concerning ways of using instruments and methods of measuring. In few marketplace, people handle the bottom and top edge of the volumetric instrument with their two fingers to measure. People are not necessarily heaping mass over the rear of volumetric instruments in this context. Elsewhere, people handle the centre or upper of measures using two hands after heaping mass on the top rear of instruments. Further, common applied measuring ways are heaping of the cereal over the rear of measures. However, the quantity of heaped cereals over the rear of instruments might not be the same in amount. In this case, the source of variation is not due to instrument error but

due to confusion or disagreement, regarding the measurements of quantity. Away from these realities, no one can be certain whether over repeated measurement clustered to some average value. Here, the extent to which measurement conform to some pre-specified value was evaluated in the marketplace by testing over repeated measurement of each farmer and small trader.

Additionally, two to three market divisions are structured within a marketplace based on measuring instruments being used for trade. In a division, for instance, a teff cereal measured by can by one party may not be equivalent to another when it is measured and converted into kilogrammes. In another assertion, when merchant use multiple measuring instruments or local norms are unclear, the question of unreliability arise. At this time, nothing is known in all hierarchy of marketplace whether measurements are uniform in between farmers and small traders (buyers). Based on these facts, it is very essential to look at measurement uniformity among the actors. The detail study framework applied for the measurement reliability of districts' marketplace is depicted in Figure 4 framework.

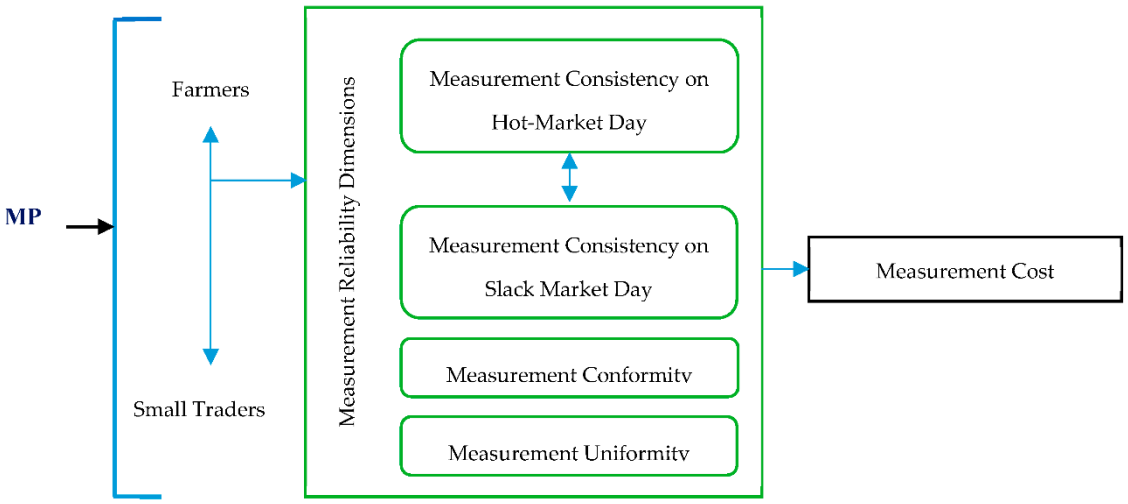

Figure 4. The farmer and small trader local units' unreliability based measurement costs.

4. Results and Discussion

This section comprises the demographic characteristics of trading parties, type and variety of traded items and marketplace conversion convention and quantity of local units' actual values distribution. In addition, the mean comparison of the actual value of the cereals number of units of measurement was subsequently presented. In the last part of the section, the measuring instruments' error and unreliability associated costs magnitude of both farmers and small traders was computed and discussed.

4.1. Demographic Characteristics of Respondents

The study found that there was high female farmer percentage in Dendi, Bako Tibe and Adea Berga (Table 1a). In contrast, there was high percentage of male farmers in Gimbichu, Adea and Lume (Table 1b). As indicated in Table 1b, most small traders in all local marketplaces were female. Besides, the age and education of most farmers and small trade participants fall between the range of 20–40 and 0–4 schooling years, respectively (Table 1a,b). With regards to marital status, most farmers and small traders were married (Table 1a,b).

4.2. Type and Variety of Cereal Commodity Traded

The study used sack unit for counting the type and variety of cereal commodities supplied; because sack is commonly used tool to transport agricultural commodities to marketplace. The study finding showed that the majority of farmers and small traders traded one type of cereals on one market day (Table 2). In the other way, the farmer and small trader who were selling more than one type of

cereal was less. Most farmers were trading teff and wheat cereals in all study districts (Table 2). On the other hand, the small traders were supplying and trading teff, wheat, maize and sorghum dominantly (Table 2). Moreover, the most variety of cereals provided by both farmers and small traders was a white variety (Table 2).

Table 1. Demographic characteristics of farmers and small traders.

Items		Study Area					
		Dendi Count (%)	**Bako Tibe Count (%)**	**Adea Berga Count (%)**	**Gimbichu Count (%)**	**Adea Count (%)**	**Lume Count (%)**
				(a)			
Gender	Male	43(47.25%)	28(41.79%)	28(43.08%)	43(76.79%)	38(56.72%)	29(53.70%)
	Female	48(52.75%)	39(58.21%)	37(56.92%)	13(23.21%)	29(43.28%)	25(46.30%)
Age	≤20	11(12.09%)	9(13.43%)	12(18.46%)	8(14.29%)	0(0%)	2(3.70%)
	20–40	63(69.23)	44(65.67%)	38(58.46%)	30(53.57%)	51(76.12%)	34(62.96%)
	>40	17(18.68%)	14(20.90%)	15(23.08%)	18(32.14%)	16(23.88%)	18(33.34%)
Marital status	Single	28(30.77%)	21(31.34%)	16(24.62%)	12(21.43%)	4(5.97%)	14(25.93%)
	Married	63(69.23%)	46(68.66%)	49(75.38%)	44(78.57%)	63(94.03%)	40(74.07%)
Education	0-4	70(76.92%)	47(70.15%)	51(78.46%)	44(78.57%)	64(95.52%)	43(79.63%)
	5-8	12(13.18%)	14(20.90%)	12(18.46%)	7(12.50%)	2(2.98%)	9(16.67%)
	≥9	9(9.90%)	6(8.95%)	2(3.08%)	5(8.93%)	1(1.50%)	2(3.70%)
Total		91(100%)	67(100%)	65(100%)	56(100%)	67(100%)	54(100%)
				(b)			
Gender	Male	2(4.65%)	3(9.09%)	5(16.13%)	12(38.71%)	6(18.18%)	4(12.90%)
	Female	41(95.35%)	30(90.91%)	26(83.87%)	19(61.29%)	27(81.82%)	27(87.10%)
Age	≤20	0(0%)	0(0%)	2(6.45%)	1(3.23%)	1(3.03%)	2(6.45%)
	20–40	27(62.79%)	28(84.85%)	23(74.19%)	22(70.97%)	23(69.70%)	18(58.06%)
	>40	16(37.21%)	5(15.15%)	6(19.35%)	8(25.81%)	9(27.27%)	11(35.48%)
Marital status	Single	0(0%)	3(9.09%)	5(16.13%)	4(12.90%)	5(15.15%)	6(19.35%)
	Married	42(97.67%)	30(90.91%)	26(83.87%)	27(87.10%)	28(84.85%)	25(80.65%)
	Divorced	1(2.33%)	0(%)	0(%)	0(0%)	0(%)	0(0%)
Education	0–4	30(69.77%)	21(63.64%)	28(90.32%)	30(96.77%)	31(93.94%)	28(90.32%)
	5–8	9(20.93%)	8(24.24%)	2(6.45%)	1(3.23%)	2(6.06%)	3(9.68%)
	≥9	4(9.30%)	4(12.12%)	1(3.23%)	0(%)	0(0%)	0(0%)
Total		43(100%)	33(100%)	31(100%)	31(100%)	33(100%)	31(100%)

Source: Field survey, 2018.

4.3. Marketplace Conversion Convention and the Distribution of Actual Values of the Measurement

Figure 5A–G illustrated the actual value of the quantity of units of measurement (in kilogram (kg)) based on marketplace conversion agreement between each local measures and kilogram unit. The quantity of local units' values was measured and recorded by considering estimated uncertainty of measurement (showed in the Table A4). The finding indicated that all actual values of cereal quantity of two bowl unit were scattered far below the conversion convention point for both farmers and small traders (Figure 5A). In Bako Tibe, most of the values of the quantity of three glasses were scattered below the conversion point (Figure 5B). In contrast, the quantity of the three can (Merti) unit was greater than the conversion volume in the Adea Berga district (Figure 5C). In Figure 5D, the cereal amount of a sack unit ranged from 40 to 86 kg in Gimbichu, Adea and Lume districts. Most of the actual values of the cereal amount of three cans unit were dispersed above the point of the convention for both farmers and small traders in Gimbichu and Adea marketplace (Figure 5E,F). In the Lume district, most of the cereals amount of the jug unit values for farmers were scattered above the point of agreement. In contrast, most of the values of the jug unit for small traders were dotted below the point of convention (Figure 5G).

Table 2. Type and variety of cereal commodity traded within the local marketplace.

Study Area	Marketplace Actors	Sample Size (n)	Type of Cereals Traded	Variety of Cereals				Total
				White	Red	Mixed	Black	
Dendi	Farmers	91	Teff	24	6	5	-	35
			Wheat	36	2	0	-	38
			Barley	19	0	0	-	19
	Small traders	43	Teff	4	4	1	0	6
			Wheat	6	1	0	0	7
			Barley	6	0	1	1	8
			Maize	14	0	0	0	14
			Sorghum	8	4	0	0	12
Bako Tibe	Farmers	67	Teff	36	4	2	-	42
			Wheat	8	0	0	-	8
			Barley	3	0	0	-	3
			Maize	11	0	0	-	11
			Sorghum	3	0	0	-	3
	Small traders	33	Teff	14	1	-	0	15
			Wheat	6	0	-	0	6
			Barley	4	0	-	2	6
			Maize	2	0	-	0	2
			Sorghum	5	1	-	0	6
Adea Berga	farmers	65	Teff	15	5	2	0	22
			Wheat	21	0	0	0	21
			Barley	14	0	0	1	15
			Maize	3	0	0	1	4
			Sorghum	3	1	0	0	4
	Small traders	31	Teff	12	5	2	-	19
			Maize	7	0	0	-	7
			Sorghum	3	3	1	-	7
Gimbichu	Farmers	56	Teff	12	11	-	-	23
			Wheat	32	7	-	-	39
			Sorghum	0	1	-	-	1
	Small traders	31	Teff	5	6	-	-	11
			Wheat	7	0	-	-	7
			Barley	5	0	-	-	5
			Maize	8	0	-	-	8
			Sorghum	2	0	-	-	2
Adea	Farmers	67	Teff	29	13	3	-	45
			Wheat	26	2	0	-	28
			Barley	5	0	0	-	5
	Small traders	33	Teff	10	4	4	-	18
			Wheat	12	0	0	-	12
			Barley	4	0	0	-	4
Lume	Farmers	54	Teff	28	1	7	-	36
			Wheat	23	0	0	-	23
			Barley	11	0	0	-	11
	Small traders	31	Teff	11	1	-	-	12
			Wheat	13	0	-	-	13
			Barley	3	0	-	-	3
			Maize	5	0	-	-	5
			Sorghum	1	2	-	-	3

Source: Field survey, 2018.

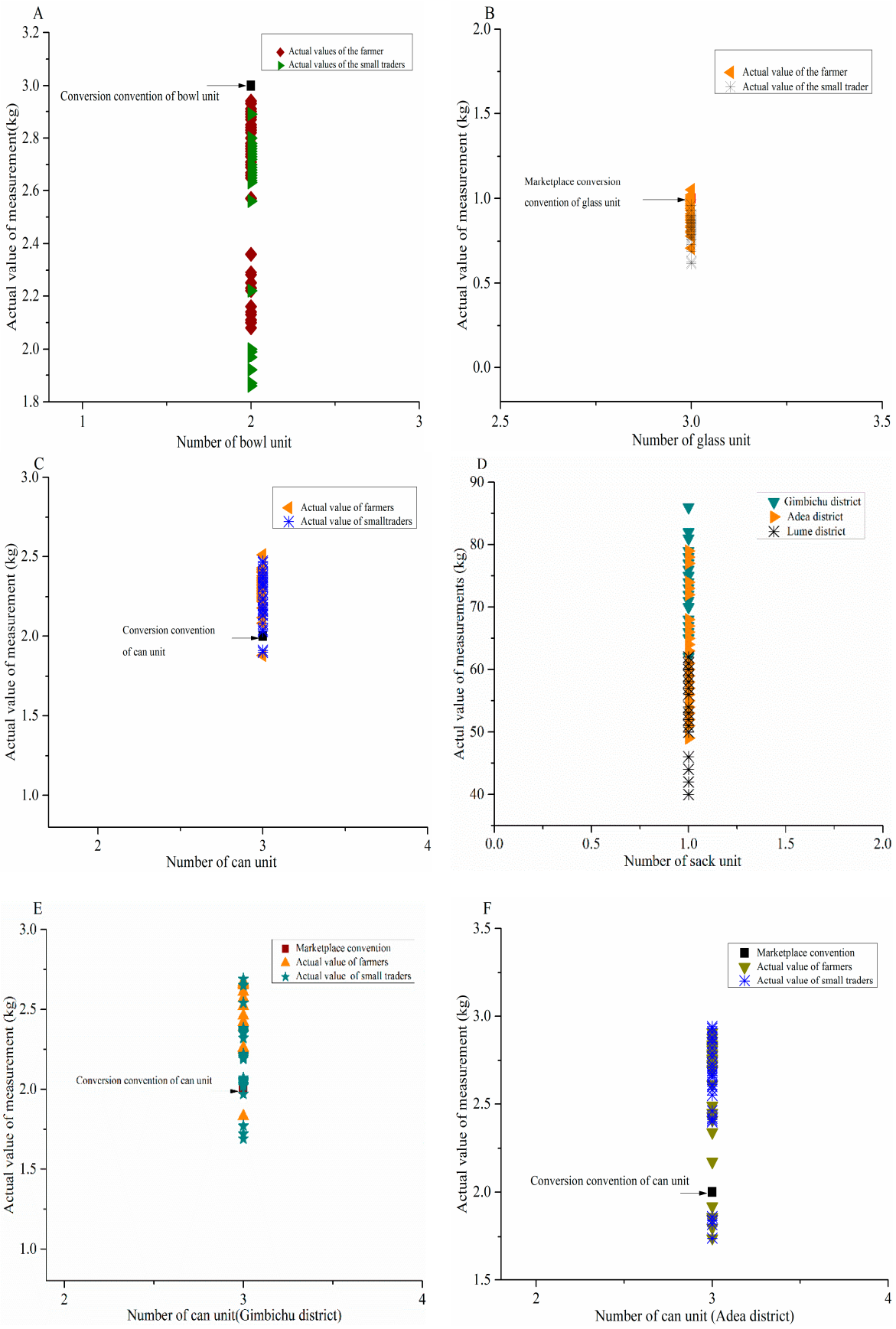

Figure 5. *Cont.*

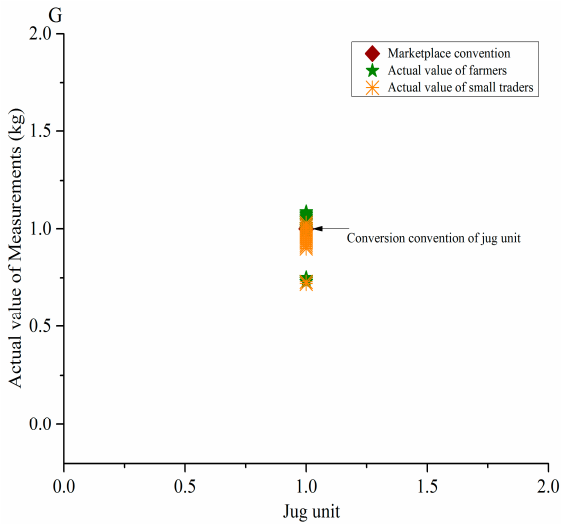

Figure 5. Actual measurement values distribution of local units.

In general, the result revealed that the conversion agreement between measuring instruments and kilogram unit was basically fundamental for trading parties from two essential aspects. Marketplace converting agreement serves the market to adjust the price of the quantity of measuring units with metric units' price that issued and set at the national level. Because the commodity price information provided by the government and agencies in Ethiopia depend on the kilogram unit measurement system. Additionally, reckoning convention helps traders to adjust the price of cereals amount of a particular unit to other sales location measuring instruments while they are trading from one marketplace to other market locations. In fact, such basic function of trading requires the reliability of local measurement system. However, when the cereals amount of local units were converted to kilogram units using site calibration, as depicted in Figure 5A–G, the actual values of measurement were highly scattered. These implied that the commodity amount was costly to transfer from one economic agent to the other. Hence, using homogenous measurement units would mean the system would have huge potential to alleviate the non-uniformity of values of the measurement.

4.4. Comparison of Actual Values Mean of Cereals Quantity of Local Units

Independent samples *t*-test was employed to compare the actual values summation mean of each cereal quantity of local units (Table 3). The number of values of measurement was taken based on the marketplace conversion convention of each unit. Cereal quantity of two bowl unit, for instance, has been taken as a benchmark in Dendi marketplace for converting the quantity of bowl to kilogram unit, which is equivalent to three kilograms. Hence, two actual values were regarded for the bowl unit to compute *t*-test. The comparison was also done by considering similar cereal marketed both by farmers and small traders. The results showed that the farmers and small traders actual average value of teff and wheat quantity of glass, can (White Oats) and jug unit were significantly different in Bako-Tibe, Gimbichu and Lume districts, respectively (Table 3). In addition, the average value of barley quantity of bowl and jug unit in Dendi and Lume; sorghum quantity of glass and can (White Oats) in Bako Tibe and Gimbichu were statistically varied, respectively.

Table 3. Actual values mean of cereals quantity of local units comparison between farmer and small trader.

Study Area	Kind of Cereals Traded	Marketplace Participants	Local Unit	Actual Values Summation Mean (kg)	SD	*T*-Value	df	Sig. (2-tailed)
Dendi	Teff	Farmers	bowl	2.76	0.216	0.390	42.00	0.699
		Small traders	"	2.73	0.051			
	Wheat	Farmers	"	2.75	0.150	0.622	43	0.537
		Small traders	"	2.72	0.071			
	Barley	Farmers	"	2.33	0.272	4.471	10.52	0.000 ***
		Small traders	"	1.98	0.113			
Bako Tibe	Teff	Farmers	glass	0.95	0.617	9.103	51.59	0.000 ***
		Small traders	"	0.84	0.028			
	Wheat	Farmers	"	0.89	0.015	6.496	6.80	0.000 ***
		Small traders	"	0.81	0.031			
	Barley	Farmers	"	0.76	0.047	1.213	8	0.260
		Small traders	"	0.71	0.066			
	Maize	Farmers	"	0.90	0.059	3.109	11	0.010 **
		Small traders	"	0.77	0.000			
	Sorghum	Farmers	"	0.96	0.021	2.457	7	0.044 *
		Small traders	"	0.87	0.066			
Adea Berga	Teff	Farmers	can	2.37	0.040	2.005	25.57	0.056
		Small traders	"	2.33	0.083			
	Maize	Farmers	"	2.14	0.178	−0.240	3.041	0.826
		Small traders	"	2.16	0.019			
	Sorghum	Farmers	"	2.14	0.074	−1.298	9	0.226
		Small traders	"	2.05	0.124			
Gimbichu	Teff	Farmers	can	2.58	0.123	2.795	16	0.013 *
		Small traders	"	2.41	0.132			
	Wheat	Farmers	"	2.44	0.119	2.728	13	0.017 *
		Small traders	"	2.25	0.147			
	Sorghum	Farmers	"	2.07	0.007	33.941	2	0.001 **
		Small traders	"	1.83	0.007			
Adea	Teff	Farmers	can	2.78	0.178	−0.223	32	0.825
		Small traders	"	2.79	0.099			
	Wheat	Farmers	"	2.50	0.096	−1.183	20	0.251
		Small traders	"	2.56	0.113			
	Barley	Farmers	"	1.87	0.067	1.338	7.00	0.223
		Small traders	"	1.82	0.053			
Lume	Teff	Farmers	jug	1.06	0.016	8.148	20	0.000 ***
		Small traders	"	1.01	0.016			
	Wheat	Farmers	"	1.00	0.012	3.199	17	0.005 **
		Small traders	"	0.97	0.023			
	Barley	Farmers	"	0.74	0.010	2.739	6	0.034 *
		Small traders	"	0.72	0.010			

*, ** and *** denoted that the mean difference is significant at 1, 5 and 0 percent, respectively. Source: Field survey, 2018.

In contrast, the average value of teff and wheat amount by bowl unit in Dendi; teff, wheat and barley quantity by can (Bebelac) unit in Adea; teff, maize and sorghum by can (Merti) unit in Adea Berga; and maize quantity by glass in Bako Tibe were not significantly different (Table 3). On the other hand, the small trader actual value means of cereals quantity of local units were less than the farmers except for maize quantity by the glass in Bako Tibe; and teff and wheat quantity by the can in Adea (Table 3). These varied values of the quantities of units between farmers and small traders implied that there was either a difference in measuring units of the same kind, method of measuring,

ways of using instruments or diverse mechanisms exist among parties enabling them to cheat each other [2]. This implied that there was measurement cost occurred due to unreliable measurement system of the marketplace. In another assertion, imprecision of measuring units led trading parties to gain or lose a certain amount of cereals while measurement was performed. To the context, such cereal marketing measurement costs can be saved through supporting trade using effective market institutions and policies.

4.5. Comparison of Actual Values of Cereals Quantity of Sack Unit

In the three districts (Gimbichu, Adea and Lume) farmers were using sack unit to trade cereals. Traders having good potential were buying up commodity using sack and resell them to others neighbouring cities using kilogram unit. Small traders were not using sack unit for transacting cereals within the marketplace. Hence, the study conducted one sample *t*-test to compare cereals amount of sack value mean of farmers in each district. To run this test, the conversion convention value of the quantity of sack for each cereal was taken as population value.

The conversion convention value of the amount of a sack is varied particularly depending on the method of measuring, ways of using sack instrument and types of the sack. In Gimbichu, farmers were ranging a sack value from 74–80 kg and 69–77 kg for teff and wheat quantity, respectively. Teff and wheat quantity of a sack in Adea district, however, was about 65 kg and 60–64 kg, respectively. On another hand, teff, wheat and barley quantity of a sack in Lume are falling in the range of 58–62 kg, 50–54 kg and 40–44 kg, respectively. Hence, the study considered the average of those ranges as population value (test value) of each cereal to compare the actual values mean with test value (Table 4).

Table 4. Comparison of values means of cereals quantity of the sack unit.

District	Kind of Cereal	Test Value (kg)	Mean (kg)	Std. Deviation	*T*-Value	df	Sig. (2-tailed)	Mean Difference (kg)
Gimbichu	Teff	77	72.06	7.11	−2.78	15	0.014 **	−4.94
	Wheat	74	74.19	4.53	0.24	30	0.814	0.19
Adea	Teff	65	62.83	8.06	−1.45	28	0.158	−2.17
	Wheat	62	59.44	5.06	−2.15	17	0.047 **	−2.56
Lume	Teff	60	57.62	2.70	−4.51	25	0.000 *	−2.38
	Wheat	52	52.65	2.18	1.23	16	0.238	0.65
	Barley	42	43.00	2.10	1.17	5	0.296	1.00

* and ** denoted that the mean difference is significant at 1 and 5 percent, respectively. Source: Field survey, 2018.

The results revealed that the mean significance difference for teff quantity of a sack unit in Gimbichu and Lume and wheat quantity of a sack in Adea were significant (Table 4). On the other hand, the mean of the quantity of wheat per sack in Gimbichu and Lume; teff per sack in Adea; and barley per sack in Lume were not significantly different (Table 4). Yet, the finding clearly showed that the measurement cost occurred for the sack unit (Table 4). From this finding point of view, the sack based quantity measurement and trade is the economy of estimation. In this context, the study suggests either to adopt the standardization of the international measurement unit or develop national idiosyncratic standard measures to reduce such cereals quantity lose.

Local markets have different market conversion convention for cereal quantity of a sack estimated to kilogram unit. These situations were emanated from different kind of sacks, methods of measuring and way of using sack measuring instrument [2]. To test whether those conditions have an impact on cereals quantity of a sack value difference, the analysis of variance was conducted. The result was indicated that teff and wheat quantity of sack unit value mean comparison of three districts were significantly varied (Table 5). From these findings, it inferred that the diverse type of sack unit, method of measuring and ways of using sack instrument were highly influencing quantity variation. Toward these, the policy and institutional intervention are vital to govern the farmer behaviour related to sack

measurement system. Effective policy and interventions will reduce costly transfer of cereal quantity that occurs due to varied usage of sack unit.

Table 5. The actual value means of cereals quantity of sack instrument comparison.

Kind of Cereal		Sum of Squares	df	Mean Square	F	Sig.
Teff	Between Groups	2068.771	2	1034.385	25.492	0.000 *
	Within Groups	2759.229	68	40.577		
	Total	4828.000	70			
Wheat	Between Groups	5760.365	2	2880.182	160.980	0.000 *
	Within Groups	1127.166	63	17.892		
	Total	6887.530	65			

* denoted that the mean difference is significant at less than 1 percent. Source: Field survey, 2018.

4.6. Local Measuring Instruments' Error Associated Measurement Costs Magnitude

Based on the Figure 3 cost estimation framework, the actual measurement summation average of cereal quantity of each measuring unit was computed separately for farmers and small traders thereby taken as ideal value. In the measurement cost computation, the marketplace conversion convention between local measures and kilogram unit was used as a baseline to estimate the measurement cost size over trading parties' total marketed cereals. Besides, the computation assumed that the price of cereal quantity of local units over total supply marketing was identical.

The finding showed that the estimated average measurement cost magnitude over total teff, wheat and barley traded was ranging from 1.49–4.96 kg (23.42–56.39 birr) for framers and 0.64–2.67 kg (9.91–36.59 birr) for small traders in Dendi district (Table 6). Comparatively, the small traders' maize and sorghum quantity lost in birr were lowest (Table 6). The small traders' measurement costs mean of total crop traded in terms of kg and birr were less than that of the farmer (Table A1). However, the mean difference of cereal amount lost between farmers and small traders was not significant except for teff per birr (Table A2). In Bako Tibe, the amount of lost quantity was extended from 8.21 to 42.13 birr for farmers and 22.02 to 53.42 birr for small traders (Table 6). The small traders' quantity lost the amount of each cereal was greater than farmers in Bako-Tibe except for teff and sorghum. However, the average value summation of the quantity of three glasses of farmers was higher than that of the small traders (Table 6). The *t*-test showed that the mean quantity lost in terms of kg and birr were not significantly different (Table A2).

In Adea Berga, the maximum costs incurred on the total supply of farmers was 17.93 birr (Table 6). On the other hand, 3.31 birr for maize and 42.43 birr for teff crop were lost by small traders (Table 6). The measurement cost average of farmers for teff was less than that of the small traders, while the mean amount loss of maize was higher for farmers (Table A1). In contrast, the farmers' average value of teff quantity of three cans was higher than that of the small traders (Table 6). The *t*-test showed that the mean difference for teff and maize quantity lose in terms of kg and birr were significant except for maize quantity lose in birr (Table A2).

Table 6. Local units' error associated measurement costs (in kg and birr).

District	Marketplace Actor	Type of Cereal	Marketplace Conversion Convention	Actual Value Means (kg)	Gained or Lost Quantity	Measurement Costs Mean over Market Convention Conversion of Local Unit		Measurement Costs Mean over Total Supply Kg (birr)	
						Mean kg (birr)	SD Kg (birr)	Mean Kg (birr)	SD Kg (birr)
Dendi	Farmers	teff	the quantity of 2 bowls =3 kg	2.76	gained	0.23(2.06)	0.29(7.66)	5.87(154.39)	8.10(224.08)
			"	"	lost	0.10 (6.02)	0.06(1.19)	1.49(29.83)	1.06(21.26)
		wheat	"	2.75	gained	0.15(2.74)	0.21(3.97)	3.24(58.98)	4.72(88.98)
			"	"	lost	0.65(0.95)	0.04(0.56)	1.49(23.42)	1.13(18.51)
		barley	"	2.33	gained	0.17(2.45)	0.75(1.15)	3.86(57.00)	2.83(41.90)
			"	"	lost	0.36(4.05)	0.16(1.83)	4.96(56.39)	2.73(30.64)
	Small traders	teff	"	2.73	gained	0.04(0.82)	0.04(0.87)	1.29(26.27)	1.55(31.78)
			"	"	lost	0.04(0.74)	0.04(0.79)	1.22(25.75)	1.28(27.30)
		wheat	"	2.72	gained	0.16(2.00)	-(-)	2.13(26.56)	-(-)
			"	"	lost	0.02(0.36)	0.09(0.29)	0.64(9.91)	0.44(6.85)
		barley	"	1.98	gained	0.08(1.33)	0.03(0.61)	1.51(25.09)	0.76(11.63)
			"	"	lost	0.06(0.91)	0.10(1.39)	2.67(36.59)	4.83(65.03)
		maize	"	2.68	gained	0.03(0.24)	0.01(0.11)	0.83(6.91)	0.53(4.44)
			"	"	lost	0.02(0.19)	0.03(0.23)	0.77(6.17)	0.99(7.94)
		sorghum	"	2.67	gained	0.02(0.22)	0.01(0.13)	0.58(6.19)	0.43(4.60)
			"	"	lost	0.02(0.25)	0.01(0.09)	0.70(8.28)	0.44(5.34)
Bako Tibe	Farmers	teff	quantity of 3 glasses = 1 kg	0.95	gained	0.07(1.16)	0.03(0.63)	2.59(45.72)	1.89(33.68)
			"	"	lost	0.44(0.67)	0.03(0.45)	2.69(42.13)	1.94(31.09)
		wheat	"	0.89	gained	0.01(0.14)	0.01(0.12)	0.47(6.57)	0.43(6.00)
			"	"	lost	1.58(0.16)	3.12(0.11)	0.63(8.21)	0.42(5.47)
		barley	"	0.76	gained	0.05(1.22)	-	3.95(89.25)	-
			"	"	lost	0.53(0.35)	0.87(0.36)	1.70(34.26)	2.16(43.06)
		maize	"	0.90	gained	0.07(0.34)	0.32(0.14)	4.33(19.00)	1.78(7.91)
			"	"	lost	0.03(0.15)	0.03(0.14)	2.90(12.66)	1.80(9.67)
		sorghum	"	0.96	gained	0.02(0.21)	-	2.09(22.05)	-
			"	"	lost	0.01(0.10)	0(0)	0.83(8.54)	0.17(1.88)
	Small traders	teff	"	0.84	gained	0.03(0.62)	0.01(0.28)	2.76(52.44)	3.04(57.38)
			"	"	lost	0.02(0.28)	0.01(0.19)	2.20(39.04)	1.72(29.07)
		wheat	"	0.81	gained	0.03(0.47)	0.01(0.16)	1.64(25.66)	0.62(9.92)
			"	"	lost	1.02(0.21)	2.00(0.27)	1.56(22.02)	2.22(31.15)
		barley	"	0.71	gained	0.06(1.25)	0.04(1.01)	6.89(124.52)	5.70(90.76)
			"	"	lost	0.89(0.47)	1.88(0.34)	3.60(42.55)	3.44(40.38)
		maize	"	0.77	gained	0.04(0.49)	0.03(0.33)	3.60(44.35)	2.19(27.71)
			"	"	lost	0.08(0.85)	0.02(0.21)	5.07(53.42)	1.23(11.84)
		sorghum	"	0.87	gained	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)
			"	"	lost	-	-	-	-

Table 6. *Cont.*

District	Marketplace Actor	Type of Cereal	Marketplace Conversion Convention	Actual Value Means (kg)	Gained or Lost Quantity	Measurement Costs Mean over Market Convention Conversion of Local Unit		Measurement Costs Mean over Total Supply Kg (birr)	
						Mean kg (birr)	SD Kg (birr)	Mean Kg (birr)	SD Kg (birr)
Adea Berga	Farmers	teff	quantity of 3 cans = 2 kg	2.37	gained	0.02(0.49)	0.03(0.69)	0.67(13.95)	1.15(24.30)
			"	"	lost	0.05(0.84)	0.01(0.28)	0.74(13.77)	0.33(6.74)
		wheat	"	2.29	gained	0.03(0.45)	0.01(0.23)	0.77(12.14)	0.77(12.37)
			"	"	lost	0.03(0.52)	0.03(0.52)	0.57(8.98)	0.44(7.14)
		barley	"	2.29	gained	0.04(0.76)	0.04(0.70)	0.57(10.21)	0.53(9.89)
			"	"	lost	0.07(1.09)	0.08(1.12)	0.67(10.83)	0.42(6.74)
		maize	"	2.14	gained	0.26(2.08)	-	2.77(22.07)	-
			"	"	lost	0.09(0.62)	0.05(0.37)	1.78(13.00)	1.59(12.02)
		sorghum	"	2.14	gained	0.03(0.36)	0.02(0.14)	1.21(11.80)	1.45(11.55)
			"	"	lost	0.11(1.61)	-	1.22(17.93)	-
	Small traders	teff	"	2.33	gained	0.06(1.25)	0.04(0.86)	1.52(30.54)	1.55(30.90)
			"	"	lost	0.06(1.24)	0.04(0.78)	2.21(42.43)	1.52(31.06)
		maize	"	2.16	gained	0.02(0.12)	0.02(0.11)	0.76(5.69)	0.69(4.94)
			"	"	lost	0.02(0.11)	0.01(0.05)	0.48(3.31)	0.22(1.52)
		sorghum	"	2.05	gained	0.03(0.36)	0.02(0.14)	1.21(11.80)	1.45(11.55)
			"	"	lost	0.11(1.61)	-	1.22(17.93)	-
Gimbichu	Farmers	teff	sack unit	72.06	gained	-	-	5.28(116.43)	3.03(70.16)
			"	"	lost	-	-	6.79(134.89)	4.29(86.29)
		wheat	"	74.19	gained	-	-	3.32(49.52)	3.55(49.95)
			"	"	lost	-	-	3.54(56.89)	2.12(34.76)
	Farmers	teff	quantity of 3 cans = 2 kg	2.58	gained	0.18(4.15)	0.02(0.54)	2.58(61.31)	0.85(20.60)
			"	"	lost	0.07(1.29)	0.02(0.44)	0.34(6.17)	0.21(3.87)
		wheat	"	2.44	gained	0.19(2.95)	0.01(0.12)	1.64(26.19)	0.07(1.17)
			"	"	lost	0.06(0.92)	0.05(0.84)	0.33(4.95)	0.34(4.83)
	Small traders	teff	"	2.41	gained	0.06(1.32)	0.24(0.58)	0.88(19.34)	0.64(14.53)
			"	"	lost	0.26(4.97)	0.28(0.92)	2.40(45.34)	0.45(5.02)
		wheat	"	2.25	gained	0.07(1.20)	0.61(1.09)	1.77(29.36)	2.02(35.47)
			"	"	lost	0.18(2.49)	0.16(2.06)	0.54(7.78)	0.43(6.62)
		barley	"	1.79	gained	0.05(0.75)	0.04(0.55)	1.72(24.39)	1.17(16.20)
			"	"	lost	0.18(2.16)	-	1.37(16.43)	-
		maize	"	2.05	gained	0.02(0.05)	0.01(0.03)	0.63(1.86)	0.37(1.08)
			"	"	lost	0.02(0.05)	0.01(0.02)	0.80(2.35)	0.14(0.42)
			"	"	No g/l	0.00(0.00)	-	0.00(0.00)	-

Table 6. *Cont.*

District	Marketplace Actor	Type of Cereal	Marketplace Conversion Convention	Actual Value Means (kg)	Gained or Lost Quantity	Measurement Costs Mean over Market Convention Conversion of Local Unit		Measurement Costs Mean over Total Supply Kg (birr)	
						Mean kg (birr)	SD Kg (birr)	Mean Kg (birr)	SD Kg (birr)
Adea	Farmers	teff	sack unit	62.83	gained	-	-	6.23(138.97)	3.50(111.56)
			"	"	lost	-	-	6.67(172.48)	5.83(161.30)
		wheat	"	59.44	gained	-	-	3.26(46.88)	2.82(44.32)
			"	"	lost	-	-	5.13(75.27)	2.99(43.22)
	Farmers	teff	quantity of 3 cans = 2 kg	2.78	gained	0.23(1.55)	0.25(1.80)	0.99(6.95)	1.06(7.75)
			"	"	lost	0.07(0.51)	0.05(0.34)	0.37(2.66)	0.23(1.63)
		wheat	"	2.50	gained	0.05(0.27)	0.06(0.28)	0.58(2.88)	0.76(3.63)
			"	"	lost	0.09(0.46)	0.08(0.39)	1.15(5.88)	1.63(8.49)
		barley	"	1.87	gained	0.07(0.30)	0.00(0.00)	0.68(2.91)	0.69(2.94)
			"	"	lost	0.05(0.20)	0.03(0.12)	0.57(2.41)	0.40(1.72)
	Small traders	teff	"	2.79	gained	0.09(0.61)	0.06(0.36)	1.02(6.85)	0.72(4.72)
			"	"	lost	0.08(0.53)	0.05(0.34)	0.53(3.62)	0.44(3.11)
			"	"	No g/L	0.00(0.00)	-	0.00(0.00)	-
		wheat	"	2.56	gained	0.09(1.42)	0.07(1.03)	0.43(6.39)	0.42(6.18)
			"	"	lost	0.09(1.24)	0.71(0.61)	0.73(10.11)	0.61(8.54)
		barley	"	1.82	gained	0.05(0.69)	0.06(0.78)	0.35(4.68)	1.18(2.47)
			"	"	lost	0.02(0.26)	0.01(0.18)	0.14(1.72)	0.15(1.94)
Lume	Farmers	teff	sack unit	57.62	gained	-	-	2.16(49.94)	1.76(44.67)
			"	"	lost	-	-	2.15(46.59)	1.42(30.18)
		wheat	"	57.62	gained	-	-	1.65(25.97)	0.86(13.78)
			"	"	lost	-	-	1.85(26.79)	1.60(23.06)
		barley	"	43	gained	-	-	1.67(18.50)	1.15(13.25)
			"	"	lost	-	-	1.67(17.00)	1.15(11.25)
	Farmers	teff	quantity of 1 jug = 1 kg	1.06	gained	0.02(0.33)	0.01(0.12)	0.49(9.71)	0.31(6.82)
			"	"	lost	0.02(0.41)	0.01(0.19)	0.36(7.36)	0.28(6.00)
			"	"	No g/l	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)
		wheat	"	1.00	gained	0.00(0.08)	0.01(0.09)	0.23(3.59)	0.24(4.01)
			"	"	lost	0.00(0.07)	0.02(0.24)	0.11(0.19)	1.71(2.92)
		barley	"	0.74	gained	0.01(0.10)	0.00(0.00)	0.24(2.29)	0.14(1.39)
			"	"	lost	0.01(0.09)	0.00(0.00)	0.30(2.69)	0.04(0.28)
			"	"	No g/l	0.00(0.00)	-	0.00(0.00)	-
	Small traders	teff	"	1.01	gained	0.02(0.44)	0.01(0.16)	0.99(22.18)	0.96(21.47)
			"	"	lost	0.01(0.28)	0.01(0.09)	0.49(10.35)	0.66(13.70)
			"	"	No g/l	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)
		wheat	"	0.97	gained	0.02(0.31)	0.01(0.13)	0.75(12.42)	0.60(10.13)
			"	"	lost	0.03(0.37)	0.02(0.31)	0.69(11.00)	0.42(7.09)
			"	"	No g/l	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)
		barley	"	0.72	gained	0.01(0.11)	-	0.21(2.31)	-
			"	"	lost	0.00(0.00)		0.00(0.00)	0.00(0.00)
		maize	"	0.93	gained	0.01(0.10)	0.01(0.09)	0.94(8.24)	0.69(6.11)
			"	"	lost	0.02(0.15)	0.01(0.11)	1.10(9.23)	0.95(7.93)
		sorghum	"	0.92	gained	0.02(0.15)	0.01(0.07)	0.91(9.06)	0.72(7.29)
			"	"	lost	0.03(0.32)	-	2.4(25.26)	-

Note: Birr is Ethiopian currency. By the end of January 2019, 1 USA dollar = 28.18 Birr. No g/L depicted zero measurement cost. Source: Field survey, 2018.

The average teff and wheat amount loss from the market day total supply by farmers in Gimbichu, Adea and Lume was 6.79 kg (134.89 birr) and 3.54 kg (56.89 birr); 6.67 kg (172.48 birr) and 5.13 kg (75.27 birr); and 2.15 kg (46.59 birr) and 1.85 kg (26.79 birr), respectively (Table 6). The measurement cost was comparatively higher in Adea district (Table 6). In contrast, the cost resulted from using a can by farmers and small traders over aggregate teff and wheat crops in Gimbichu, Adea and Lume were relatively smaller than that of the sack-related biased measurement cost. The reason was that the sack is the primary unit of measurement in those districts. Trading parties were using different can and jug tools for micro cereals marketing. The maximum average quantity loss from can and jug unit in Gimbichu, Adea and Lume was 45.34 birr, which was incurred by small traders (Table 6). On the other hand, the sum of small traders' average value of cereal quantity for three can in Gimbichu and Adea and one jug unit in Lume was smaller than that of the farmers except for teff and wheat in Adea district (Table 6). However, the *t*-test results showed that the measurement cost size means over total supply of teff and wheat for can unit were not statistically varied in Gimbichu, Adea and Lume except for teff in birr in Gimbichu (Table A2).

In this context, the result implied that the measuring unit error associated cost was higher mainly for the sack, bowl and glass units of measurement. These units were used primarily for macro cereal supply trading. Whereas, the remaining local units like can and jug were employed as an alternative or for micro-cereals supply marketing purpose. Hence, can and jug unit associated bias costs were relatively smaller. The number of farmers and small traders who lost cereals quantity was 50.54 percent (Table A3). In addition, the frequency of most farmers to conduct market within a month is two times on average [2]. This figure become higher if it is projected for all transaction days made in a year. Therefore, if a half percent of farmers and small traders of all districts faced the same situation throughout the year, a big economy loss will be incurred. In general, either the development of homogenous idiosyncratic measures or the adoption of the international metric and imperial measurement system is suggested to reduce such huge loses of cereal amount [21]. Besides, rules for governing behaviour of markets would have a huge potential for economizing measurement costs and making equitable cereals exchanges [28–31].

4.7. The Magnitude of the Cost of Local Measurement Tools Unreliability

4.7.1. Measurement Consistency

The quantity measurement consistency dimension was evaluated in the marketplace where both hot and slack market day were conducted in a week. However, the hot and slack market day were performed only for sack unit of measurement in Gimbichu district. In the remaining study sites, the hot market alone was conducted in different sales locations of the district. For this reason, the measurement consistency evaluation was limited to participating farmers of one study area. Thereby, the farmers' sample size (n = 40) was taken for two market days to evaluate the actual value and price mean comparison. The measurement consistency of teff and wheat amount of the sack unit between a hot and slack market day of Gimbichu district was indicated in Table 7. The finding showed that the actual values and transaction price mean difference was insignificant (Table 7). These results inferred that the values and price of the quantity of a sack of two market days in a week were not consistent, though the *p*-value was greater than 0.05.

Table 7. Hot and slack market day cereal quantity measurement consistency of sack unit.

Type of Cereal	Value and Price of a Sack Unit	Nature of The Market Day	Mean	SD	*T*-Value	df	Sig. (2-tailed)
Teff	Actual value (kg)	Hot market day	72.0625	7.11307	−0.897	51	0.374
		Slack market day	74.0811	7.67890			
	Transaction price (birr)	Hot market day	1512.1875	130.16616	−0.920	51	0.362
		Slack market day	1554.0541	160.30283			
Wheat	Actual value (kg)	Hot market day	74.1935	4.53446	0.546	42	0.588
		Slack market day	73.3846	4.35007			
	Transaction price (birr)	Hot market day	1159.3548	73.16354	0.692	42	0.493
		Slack market day	1139.2308	117.15101			

Source: Field survey, 2018.

4.7.2. Measurement Conformity

The same approach considered for estimating measures error related cost was also used for assessing non-conformity measurement costs. The average actual measurement value was computed and taken as acceptable or pre-specified value. The assumption was to evaluate the deviation of over repeated actual value of cereal quantity of each local unit from their average value. The non-conformity of over repeated actual values of cereal quantity of measuring units were used the conversion convention as a point of reference to estimate cost for the total supply of market actors. The price of cereal quantity of each local unit was identical throughout the total cereal amount trade transaction. The non-conformity associated costs result was the same with local units' error-related costs specified in Table 6. On the other hand, in both measurement error (Barzel) and sameness (Velkar) methods, the amount of the computed measurement cost was identical. This was possibly caused by the lack of some standard for each local measurement unit. Besides, there was a constraint for determining measurement uniformity among districts due to the heterogeneous nature of local units (see Section 4.7.3).

4.7.3. Measurement Uniformity

As clearly indicated in this study, the cereal commodity amount of the majority of local units value means of the farmers was greater than that of small traders (Table 3). In addition, the average value of the quantity of local unit between farmers and small traders were significantly different for most cereals. From these findings, one can infer that there was no uniformity among local units of measurement. The policy intervention, therefore, is fundamental towards quantity measurement heterogeneity problems.

5. Conclusions

The study was focused to cereal commodity trade quantity measurement cost and reliability in six districts' agricultural marketplace of Oromia regional state. As per the survey result, the following important findings and conclusions were drawn:

- The actual values of the quantities of local measures were dispersed far below or above the conversion point of units of measurement. The farmers' actual values mean of the quantity of most local units were greater than that of the small traders. In addition, the comparison of average values of the quantity of most local units between farmers and small traders were significantly varied. These result also indicated that there was no measurement uniformity between farmers and small traders. Moreover, the study has given insight that the diverse type of sack unit, methods of measuring and ways of using sack instrument were highly influencing quantity variation. These findings were clearly illustrated that the quantity amount was transferred costly from one trading party to the other parties.

- The estimated average costs of measuring instruments' error of total cereal commodity traded on one market day were ranging from 17–172.18 birr for sack unit, 6.17–56.39 birr for bowl unit and 8.21–53.42 birr for glass unit both for farmers and small traders. Similarly, error related costs for can (Merti), can (White Oats), can (Bebelac) and jug unit was 3.31–42.43 birr, 2.35–45.34 birr, 1.72–10.11 birr and 0.19–25.26 birr, respectively. Comparatively, the measurement costs were higher for the sack, bowl and glass units of measurement. The reliability method's quantity measurement cost extent was identical to error related costs due to the application of the same estimation approach.

In general, the study concluded that the cereal commodity trade quantity measurement of farmers and small traders were not reliable. Furthermore, the measuring units' error and unreliability related estimated average costs magnitude on one market day transaction were higher for most cereals traded except for secondary units of measurement and micro-cereals supply marketing. This indicate that, the farmers and small traders encounter loss of huge economy especially if the extent of measurement costs is projected for the total transaction days made within a year. In this manner, the spill over effects of the multiple and non-uniform unit of measurement upon local economy are enormous. Based on these facts, the study suggested the complete standardization for the cereal commodity trade measurement system. This standardization of measurement system is possible either by the development of national idiosyncratic measuring unit or adopting an international unit of measurement. Besides, institutions and policy interventions are equivalently essential for governing the measurement behaviour of actors of the marketplace. To these ends, the present study is vital in the context of sub-Saharan countries and/or at a country level to create awareness and address controversial arguments pertaining to the economic benefit of measurement. Overall, the results of this study have valuable contribution to improve agricultural market functioning, rural incomes, macroeconomic policy and national markets integration in developing countries where there are complex, multiple and non-uniform local measures.

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Conflicts of Interest: The authors declare that there is no conflict of interest.

Appendix A

Table A1. Local units' bias related measurement costs mean over total traded crops (in kg and birr).

District	Type of Cereals	Marketplace Actors	Mean	SD	Std. Error Mean
Dendi	Teff (Kg)	farmers	1.497	1.057	0.211
		small traders	0.740	0.787	0.394
	Teff (Birr)	farmers	29.829	21.256	4.251
		small traders	1.220	1.277	0.638
	Wheat (kg)	farmers	1.078	1.524	0.247
		small traders	0.770	0.349	0.156
	Wheat (birr)	farmers	16.583	24.751	4.015
		small traders	11.892	5.401	2.416
	Barley (kg)	farmers	4.962	2.732	1.115
		small traders	3.338	5.299	2.650
	Barley (birr)	farmers	56.387	30.640	12.509
		small traders	45.648	71.295	35.647
Bako-Tibe	Teff (kg)	farmers	2.600	1.969	0.386
		small traders	2.200	1.724	0.652
	Teff (birr)	farmers	40.576	31.484	6.175
		small traders	39.039	29.067	10.986
	Wheat (kg)	farmers	0.840	0.000	0.000
		small traders	3.125	2.242	1.585
	Wheat (birr)	farmers	10.940	0.000	0.000
		small traders	44.050	31.141	22.020
	Barley (kg)	farmers	4.503	3.225	1.613
		small traders	4.503	3.225	1.613
	Barley (birr)	farmers	53.190	37.682	18.841
		small traders	53.190	37.682	18.841
Adea- Berga	Teff (kg)	farmers	0.045	0.014	0.006
		small traders	2.209	1.521	0.538
	Teff (birr)	farmers	13.767	6.740	2.752
		small traders	42.434	31.065	10.983
	Maize (kg)	farmers	1.783	1.595	0.921
		small traders	0.480	0.216	0.108
	Maize (birr)	farmers	13.000	12.019	6.939
		small traders	3.308	1.519	0.760
Gimbichu	Teff (kg)	farmers	0.344	0.215	0.096
		small traders	2.400	0.453	0.320
	Teff (birr)	farmers	6.168	3.867	1.729
		small traders	45.340	5.020	3.550
	Wheat (kg)	farmers	0.332	0.344	0.141
		small traders	0.535	0.431	0.305
	Wheat (birr)	farmers	4.947	4.835	1.974
		small traders	7.780	6.619	4.680
Adea	Teff (kg)	farmers	0.373	0.232	0.067
		small traders	0.593	0.421	0.149
	Teff (birr)	farmers	2.665	1.628	0.470
		small traders	4.074	2.991	1.057
	Wheat (kg)	farmers	1.148	1.626	0.813
		small traders	0.733	0.608	0.248
	Wheat (birr)	farmers	5.875	8.488	4.244
		small traders	10.113	8.537	3.485
	Barley (kg)	farmers	0.567	0.402	0.232
		small traders	0.135	0.148	0.105
	Barley (birr)	farmers	2.410	1.716	0.991
		small traders	1.720	1.937	1.370

Table A1. *Cont.*

District	Type of Cereals	Marketplace Actors	Mean	SD	Std. Error Mean
Lume	Teff (kg)	farmers	0.357	0.281	0.162
		small traders	0.493	0.662	0.331
	Teff (birr)	farmers	7.360	6.003	3.466
		small traders	10.355	13.703	6.851
	Wheat (kg)	farmers	0.210	0.071	0.050
		small traders	0.688	0.417	0.209
	Wheat (birr)	farmers	3.330	1.160	0.820
		small traders	11.003	7.086	3.543

Table A2. Independent samples *t*-test for local units' bias related measurement costs over total supply.

District	Local Unit	Kind of Cereals	*t*-Value	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Dendi	bowl	teff (Kg)	1.365	27	0.184	0.757	0.555	−0.381	1.896
		teff (birr)	6.655	24.993	0.000 *	28.609	4.299	19.755	37.462
		wheat (Kg)	0.446	41	0.658	0.308	0.691	−1.087	1.703
		wheat (birr)	0.418	41	0.678	4.691	11.214	−17.957	27.338
		barley (kg)	0.645	8	0.537	1.624	2.516	−4.179	7.427
		barley (birr)	0.333	8	0.748	10.739	32.229	−63.581	85.059
Bako-Tibe	glass	teff (kg)	0.488	31	0.629	0.400	0.819	−1.271	2.071
		teff (birr)	0.116	31	0.908	1.537	13.214	−25.412	28.486
		wheat (kg)	−1.934	3	0.149	−2.285	1.181	−6.045	1.475
		wheat (birr)	−2.017	3	0.137	−33.110	16.413	−85.343	19.123
		barley (kg)	0.000	6	1.000	0.000	2.281	−5.581	5.581
		barely (birr)	0.000	6	1.000	0.000	2.281	−5.581	5.581
Adea-Berga	Can	Teff (kg)	−4.023	7.002	0.005 *	−2.164	0.538	−3.436	−0.892
		Teff (birr)	−2.532	7.863	0.036 *	−28.667	11.322	−54.856	−2.478
		Maize (kg)	−2.532	7.863	0.036 *	−28.667	11.322	−54.856	−2.478
		Maize (birr)	1.389	2.048	0.297	9.693	6.980	−19.677	39.062
Gimbichu	Can	Teff (kg)	−6.154	1.186	0.076	−2.056	0.334	−5.012	0.900
		Teff (birr)	−11.354	5	0.000 *	−39.172	3.450	−48.041	−30.303
		Wheat (kg)	−0.691	6	0.515	−0.203	0.294	−0.923	0.516
		Wheat (birr)	−0.671	6	0.527	−2.833	4.225	−13.173	7.506
Adea	Can	Teff (kg)	−1.504	18	0.150	−0.219	0.146	−0.525	0.087
		Teff (birr)	−1.367	18	0.188	−1.409	1.031	−3.574	0.756
		Wheat (kg)	0.580	8	0.578	0.414	0.714	−1.232	2.060
		Wheat (birr)	−0.771	8	0.463	−4.238	5.499	−16.919	8.442
		Barley (kg)	1.395	3	0.257	0.432	0.309	−0.553	1.416
		Barley (birr)	0.422	3	0.702	0.690	1.637	−4.519	5.899
Lume	Jug	Teff (kg)	−0.328	5	0.756	−0.136	0.414	−1.201	0.929
		Teff (birr)	−0.348	5	0.742	−2.995	8.610	−25.127	19.137
		Wheat (kg)	−1.518	4	0.204	−0.478	0.315	−1.351	0.396
		Wheat (birr)	−1.437	4	0.224	−7.673	5.338	−22.493	7.148

* denoted the mean difference is significant at less than 5 percent.

Appendix B

Table A3. Numbers of farmers and small traders gained and lost cereals quantity due to measurement error.

Study Site	Marketplace Actors	Type of Cereals	No of Farmers and Small Traders Who Gained Quantity	No of Farmers and Small Traders Who Lost Quantity	No of Farmers and Small Traders Who Neither Gained nor Lost Quantity
Dendi	farmers	teff	10	25	-
		wheat	11	27	-
		barely	13	6	-
	small traders	teff	4	4	-
		wheat	1	6	-
		barely	4	5	-
		maize	6	8	-
		sorghum	6	6	-
Bako-Tibe	framers	teff	16	25	-
		wheat	5	4	-
		barely	1	3	-
		maize	3	8	-
		sorghum	1	2	-
	small traders	teff	8	7	-
		wheat	3	4	-
		barely	3	5	-
		maize	2	-	-
		sorghum	4	2	-
Adea-Berga	farmers	teff	13	6	3
		wheat	9	12	-
		barely	9	6	-
		maize	1	3	-
		sorghum	3	1	-
	Small traders	Teff	10	8	-
		maize	3	4	-
Gimbichu	Farmers (sack unit)	teff	9	7	-
		wheat	16	15	-
	Farmers(can unit)	teff	2	5	-
		wheat	2	6	-
	Small traders (can unit)	teff	9	2	-
		wheat	5	2	-
		barely	4	1	-
		maize	4	3	1
Adea	Farmers(sack unit)	teff	15	14	-
		wheat	11	7	-
	Farmers(can unit)	teff	4	12	-
		wheat	6	4	-
		barely	2	3	-
	small traders (can unit)	teff	8	9	1
		wheat	6	6	-
		barely	2	2	-
Lume	Farmers(sack unit)	teff	13	13	-
		wheat	9	8	-
		barely	3	3	-
	Farmers(can unit)	teff	3	3	4
		wheat	3	3	-
		barely	2	2	1
	small traders (can unit)	teff	5	4	3
		wheat	6	4	3
		barely	1	-	-
		maize	3	2	2
Total			**302**	**327**	**18**

Appendix C

Table A4. Certificate of calibration.

District	Marketplace	Unit of Measurement	Certificate Number	Object	Calibrated Object (Manufacturer)	Date of Calibration	Type of Calibration	Measuring Range	Calibration Range	Estimated Uncertainty of Measurement [gram]
Dendi	Ginchi	bowl	OBL-0408	Digital balance	China	2018-08-27	Site calibration	0–50,000 g	200–5000 g	±0.39
Bako Tibe	Bako	glass	OBL-0398	Digital balance	"	"	"	0–50,000 g	200–5000 g	±0.39
Adea Berga	Incini	can	OBL-0406	Digital balance	"	"	"	0–50,000 g	200–5000 g	±0.39
Gimbichu	Chafe Donsa	sack	OBL-0399	Mechanical balance	Italy	2018-08-09	"	0–3000 kg	5–100 kg	±1.03
		can	OBL-0400	Digital balance	China	2018-08-09	"	0–50,000 g	200–5000 g	±0.40
Adea	Godino	sack	OBL-0404	Mechanical balance	Italy	2018-08-11	"	0–3000 kg	5–100 kg	±1.03
	Robi	sack	OBL-0409	"	Italy	2018-08-14	"	0–3000 kg	5–100 kg	±1.03
	Godino	can	OBL-0405	Digital balance	China	2018-08-11	"	0–50,000 g	200–5000 g	±0.40
	Robi	can	OBL-0410	"	"	2018-08-14		0–50,000 kg	200–5000 g	±0.40
Lume	Modjo	sack	OBL-0407	Mechanical balance	Italy	2018-08-27	"	0–3000 kg	5–100 kg	±1.03
	Ejere	sack	OBL-0401	"	"	"	"	0–3000 kg	5–100 kg	±1.03
	Modjo	jug	OBL-0408	Digital balance	China	2018-08-27	"	0–5000 g	200–5000 g	±0.39
	Ejere	jug	OBL-0402	"	"	"	"	0–5000 g	200–5000 g	±0.39

Source: Site calibration measurement collaboration with National metrology institute of Ethiopia (NMIE), 2018.

References

1. Alemu, D.; Ayele, B.G.; Behute, Y.; Beyone, R.; Dewana, B.; Fekadu, R.; Vargas, H.N.; Minot, S.R.; Taffesse, A.; Tefera, N. *Cereals Availability Study in Ethiopia, 2008, Development of a Spatial Equilibrium Modeling Approach to Study the Impact of Policy Intervention on Cereals Availability*; Joint Research Centre (JRC) Reports; Publication office of the European Union: Luxembourg, 2012.
2. Kidane, A.A.; Deyi, Z.; Bekele, G.E.; Fekadu, M.S.; Dereje, K.D.; Rajani, O. Cereal Commodity Trading in Ethiopian Local Marketplace: Examining Farmers' Quantity Measurement Behaviors. *Agriculture* **2018**, *8*, 188. [CrossRef]
3. Capeau, B.; Dercon, S. Prices, Unit Values and Local Measurement Units in Rural Surveys: An Econometric Approach with an Application to Poverty Measurement in Ethiopia. *J. Afr. Econ.* **2005**, *15*, 181–211. [CrossRef]
4. Daunton, M.J. *Progress, and Poverty: An Economic and Social History of Britain 1700–1850*; Oxford University Press: Oxford, UK, 1995.
5. Hoff, K.; Stiglitz, J.E. Introduction: Imperfect Information and Rural Credit Markets: Puzzles and Policy Perspectives. *World Bank Econ. Rev.* **1990**, *4*, 235–250. [CrossRef]
6. North, D.C. Institutions and Economic Growth: An Historical Introduction. *World Dev.* **1989**, *17*, 1319–1332. [CrossRef]
7. Williamson, O.E. *The Economic Institutions of Capitalism*; Free Press: New York, NY, USA, 1985.
8. Barzel, Y. Measurement Cost and The Organization Markets. *J. Law Econ.* **1982**, *25*, 27–48. [CrossRef]
9. Richter, R. *On the New Institutional Economics of Markets*; Bielefeld University: Bielefeld, Germany, 2008.
10. Aider, K. A Revolution to Measure: The Politician Economy of the Metric System in the Ancient Régime. In *The Values of Precision*; Wise, M.N., Ed.; Princeton University Press: Princeton, NJ, USA, 1995.
11. Connor, R.D. *The Weights and Measures of England*; HMSO: London, UK, 1987.
12. Kula, W. *Measures, and Men*; Princeton University Press: Princeton, NJ, USA, 1986.
13. Coase, R.H. The Nature of the Firm. *Economica* **1937**, *4*, 386–405. [CrossRef]
14. Coase, R.H. The Problem of Social Cost. In *The Firm, the Market, and the Law*; University of Chicago Press: Chicago, IL, USA, 1988; pp. 5–156, orig. pub. 1960.
15. Hoppit, J. Reforming Britain's weights, and measures, 1660–1824. *Engl. Hist. Rev.* **1993**, *108*, 82–104. [CrossRef]
16. Cardarelli, F. *Encyclopedia of Scientific Units, Weights, and Measures*; Their SI Equivalences and Origins; Springer Science & Business Media: Berlin/Heidelberg, Germany, 2003.
17. Wang, N. Measuring Transaction Costs: An Incomplete Survey. Working Papers 2, Ronald Coase Institute. 2003. Available online: http://www.coase.org/workingpapers/wp-2.pdf (accessed on 22 February 2019).
18. Wallis, J.J.; North, D.C. Measuring the transaction sector in the American economy, 1870–1970. In *Long Term Factors in American Economic Growth*; University of Chicago Press: Chicago, IL, USA, 1986.
19. Allen, D.W. *Transaction Costs*; Simon Fraser University: Burnaby, BC, Canada, 1999; Available online: www.sfu.ca/~{}allen/allentransactioncost (accessed on 1 March 2017).
20. Klein, G.P. *New Institutional Economics*; University of Georgia: Athens, GA, USA, 1999; Available online: www.cec.zju.edu.cn/~{}yao/uploadfile/papers/p007 (accessed on 22 February 2019).
21. Velkar, A. *Measurement Systems as Market Foundations: The Role of Mensuration in Generating Economic Knowledge, Measurements & Knowledge Manufacturing Markets*; London School of Economics: London, UK, 2009.
22. Velkar, A. *Markets, Standards, and Transactions: Measurements in Nineteenth-Century British Economy*; The London School of Economics and Political Science: London, UK, 2008.
23. CSA (Central Statistical Agency). *Agricultural Sample Survey 2015/16 (2008 E.C): Report on Area, Production, and Farm Management Practice of Belg Season Crops for Private Peasant Holdings*; Central Statistical Agency: Addis Ababa, Ethiopia, 2016; Volume V, pp. 17–29.
24. Oromia Regional State Agricultural Office. *Report on Post-Harvest Cereal Commodity Producation of Meher Season for Private Peasant Holdings*; Regional Agricultural Office: Ambo, Ethiopia, 2017; Unpublished Agricluture Office Document.
25. Zonal Agricultural Office. *Report on Post-Harvest Cereal Commodity Producation of Meher Season for Private Peasant Holdings*; Zonal Agricultural Office: Ambo, Ethiopia, 2017; Unpublished Agricluture Office Document.

26. Cochran, W.G. *Sampling Techniques*, 2nd ed.; John Wiley & Sons, Inc.: New York, NY, USA, 1963.
27. Fantu, N.B.; Guush, B.; Bart, M.; Alemayehu, S.T. *Agricultural Growth in Ethiopia (2004–2014): Evidence and Drivers*; ESSP Working Paper 81; International Food Policy Research Institute (IFPRI): Washington, DC, USA, 2015.
28. North, D.C. The New Institutional Economics and Development. 1995. Available online: http://econwpa.repec.org/eps/eh/papers/9309/9309002.ps.gz (accessed on 14 September 2016).
29. North, D.C. A Transaction Cost Theory of Politics. *J. Theor. Polit.* **1990**, *2*, 355–367. [CrossRef]
30. North, D.C. Institutions. *J. Econ. Perspect.* **1991**, *5*, 97–112. [CrossRef]
31. North, D.C. *Transaction, Institutions, and Economic Performance*; An International Center for Economic Growth Publication: San Francisco, CA, USA, 1992.